VOL. 2. NO. 2.

THE Sidereal Messenger.

Conducted by Wm. W. PAYNE,
Director of Carleton College Observatory.

APRIL, 1883.

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To impress upon the mind the reality of the perfection of the works of the omnipotent, the living GOD.—Professor JAMES C. WATSON.

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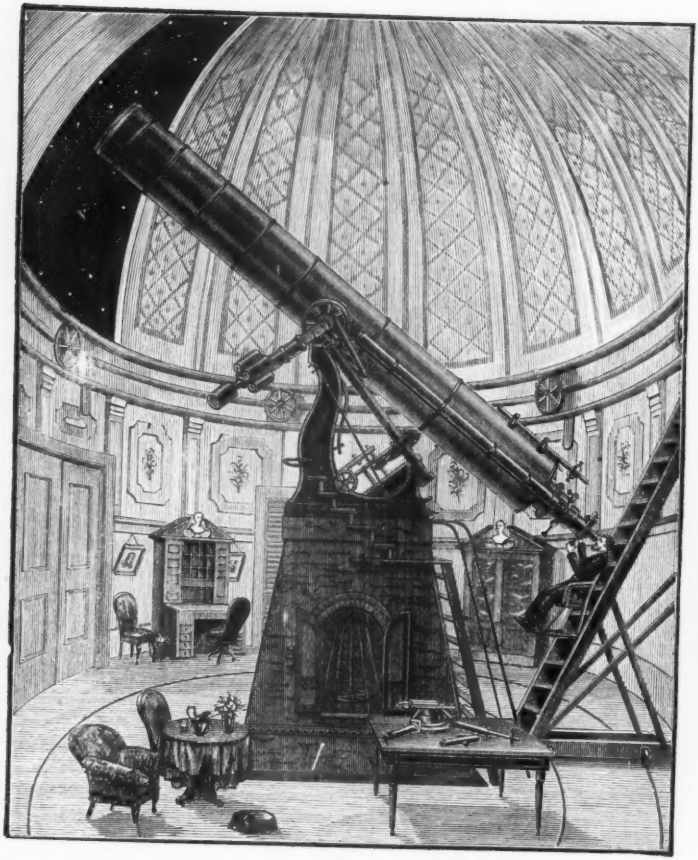

THE GREAT TELESCOPE OF THE WARNER OBSERVATORY,
ROCHESTER, N Y.

XUM

The Sidereal Messenger.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 2. NO 2. APRIL, 1883. WHOLE NO. 12.

ON THE PRESENT STATE OF THE THEORIES OF THE CELESTIAL MOTIONS.

SIMON NEWCOMB.

(Continued from last number.)

This remark is not made to discourage such attempts, because, owing to the magnitude of the work, it is desirable to utilize all investigations, wherever made, which will in any way contribute to its completion. It is, however, essential that such investigations should be made in such a way as to adapt themselves to the general plan, and that they should be completed as far as practicable. With a view of enabling those interested to form the best judgment of the situation a statement of the unpublished work now in hand, with a general programme for its continuance, is here presented.

The theories of the four inner planets naturally claim the first attention as embodying most of the fundamental elements of astronomy. This branch of the work includes not only the masses of the planets and the elements of the

respective orbits, but the constants connected with the rotation of the earth on its axis, namely, the annual precession, the obliquity of the ecliptic and its secular variation, the position of the equinox among the stars, and, indirectly, the positions of the fundamental stars. To these may be added the solar parallax and the mass of the moon, as well as a number of quantities connected with those already mentioned. In the determination of these constants the plan, as already mentioned, contemplates the utilization and combination of all valuable data.

Besides what is found on the general subject in the present volume the following works are finished or are in progress:

LAVERRIER'S tables of the *Sun*, *Mercury*, *Venus* and *Mars* have been partially reconstructed with a view of making them more convenient in use. His theory, however, remains unaltered in the manuscript tables. A comparison of the Greenwich, Paris and Washington meridian observations of *Mercury* with those tables has been commenced and is approaching completion. Similar comparisons for the *Sun*, *Venus* and *Mars* have not been seriously commenced, but it is expected to commence them in the course of the year 1883.

A discussion of the corrections required by the older Greenwich observations up to 1830, as published by Prof. AIRY, in order to reduce the results to a uniform system, is nearly completed, and is expected to appear as Volume II, Part I, of these Papers.

General tables and formulæ for forming the differential coefficients for correcting the elements of the inner planets have been prepared, and it is intended to publish them in the next volume.

Although the final completion of the theories of the other planets must follow the work on the interior planets, it is advisable to begin it without delay, owing to the great labor which it involves. The general perturbations of *Jupiter* and *Saturn* were therefore taken up by Mr. GEORGE W. HILL in 1877, but they are still unfinished. It is now expected that Mr. HILL'S work will be completed about the

end of 1883. The computation has been made principally by the methods of HANSEN.

Much attention has also been paid to the subject of the moon's motion. The first object has been the continuance of the discussion of eclipses and occultations previous to 1750 up to the present time. The reason for laying so much stress upon occultations is that notwithstanding the irregularity with which they are observed, their considerable accidental errors, and the labor of reducing them, they constitute the only observations of the moon which are free from systematic error, and which can therefore be used with safety to compare the mean longitudes of the moon at wide intervals of time.

Tabular positions of the moon, as well as those of the fixed stars, are now complete for all the more important occultations sinc 1750, and the reductions for parallax are in progress. Should the work not be intentionally delayed in order to bring it up to the date at which new tables of the moon shall be actually constructed, it may be expected that this particular discussion will be terminated by the end of 1884.

Although the theory of *Jupiter's* satellites does not form an essential part of the proposed investigations, the motions of the first satellite are intimately connected with the general subject, owing to the light which they may throw upon the question of the uniformity of the earth's rotation. All the observed and recorded eclipses of the satellites have, therefore, been computed from DAMOISEAU'S tables up to the early part of the present century. The work is discontinued for the present, owing to the difficulty of introducing and discussing the various corrections which will be required to the observations on account of different apertures of telescopes employed, the different distances of the planet from *Jupiter*, etc. It is a matter of regret to me, as it must be to all astronomers interested in this matter, that Mr. GLASENAPP has not continued the very thorough discussion of observations of these satellites which he published some six years ago.

An essential and very laborious and very difficult part of

the work is that of preparing formulæ and tables for computing the general perturbations of all the planets. A problem which has taxed the powers of the greatest mathematicians of modern times, and the solution of which is still, after all their work, in an unsatisfactory state, is one which the writer feels most hesitation in approaching. He has, however, devised a method which he hopes may prove convenient in practice for the general development of the disturbing function and its derivatives. Whether any improvements can be devised in the method of integrating must be left to the future.

In the future the work it is intended to combine the data in a way different from that generally adopted. When all four of the inner planets are considered together it is possible greatly to strengthen the results on special points. An example of this is afforded by the relation of observations on *Mercury* and *Venus* to the obliquity of the ecliptic and the position of the equinox. Hitherto these quantities have been made to depend solely upon observations of the *Sun*. Were the *Sun* a point of light which could be observed in the same way as a fixed star, the results from this method would be so far beyond doubt that we should have no occasion to look further. But there are several causes which diminish the value of solar observations. In the first place, the *Sun* being a round body and not a point of light, it is well known that a large personal difference exists in the observations of its position by different observers. Agan, it has always to be observed at mid-day, when the atmosphere is most disturbed by its rays, and when the roof of the observing room is heated from the same cause. Morover, there is always more or less danger of systematic deformation of the instrument produced by the concentration of the solar rays in the focus. It is therefore impossible to view observations of the *Sun* without a strong suspicion of systematic errors existing among them.

Now, geometrically considered, observations of *Mercury* may be utilized for determining the position of the earth's orbit relative to the equator almost as well as observations of the *Sun* itself. If we supposed the elements of the or-

bit of *Mercury* perfectly known it would be easy to reduce each observation of *Mercury* to the center of Motion. But since the elements of the planet are to be considered unknown, the question arises whether these elements and those of the earth's motion can be independently determined. That they can, to a certain extent, will be evident by the following considerations:

Let us imagine the observer to be in any fixed position on the orbit of the earth, and to observe *Mercury* from time to time through several revolutions around the *Sun*. It is evident that from these observations the orbit of the planet, and the position of the observer relative to it, could both be determined. By supposing him to move around the earth's orbit to different positions, and to repeat the determinations, we see that any number of separate determinations of the elements of the planet could be made. The several determinations would then be combined and reconciled by attributing suitable elements to his own motion around the earth's orbit.

This is substantially the actual case except that the observations from any one point of the earth's orbit do not embrace the whole orbit of *Mercury*, but only those portions of it not very near the points of conjunction with the *Sun*. Although this circumstance detracts from the completeness of the determinations it does not detract from the accuracy with which the main problem, that of the obliquity of the ecliptic and position of the equinox, can be solved. It is therefore possible, from meridian observations of *Mercury* alone, to obtain the principal elements of the earth's orbit around the *Sun*, including the absolute longitude of the *Sun* itself, and hence a separate determination for the position of the equinox. It is true that some of the elements, especially the eccentricity and longitude of the perihelion, may prove to have small weight, but this is because what is most accurately given by the observations will be a linear function of the corrections to these elements. But even such a result will furnish valuable data for the final values of the necessary quantities.

Nearly the same remarks apply to the meridian observa-

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tions of *Venus*, and, to a limited extent, to those of *Mars*. Indeed it is evident that what is given by planetary observations generally is not the absolute position of the planet but the direction of the line joining the earth and the planet, which direction is equally available for the determination of the elements of either of the two bodies. Whether it is advisable to employ it in determining both sets of elements must depend upon circumstances. If it were possible to determine the solar elements by observations of the *Sun* with an accuracy far exceeding the joint determination by observations of the planet, the latter might be entirely omitted. But, for reasons already pointed out, this is far from being the case. It seems better, therefore, under the circumstances, to ascertain what functions of the corrections to the two sets of elements can best be determined from observations of the planets, and to supply whatever is weak in the combination by observations of the *Sun* itself.

In theory, observations of the moon might also be utilized for an absolutely independent determination of the equinox and of the obliquity of the ecliptic. In fact the mean orbit of the moon during a period of one revolution of the node is the ecliptic itself, and therefore exact observations of its position through one period will give the position of the ecliptic. But the rapid motion of the moon in declination when near either equinox introduces a large probable systematic error into the measures made upon it at any definite moment. No weight can therefore properly be assigned to a position of the equinox by meridian observations of the moon. The obliquity derived from such observations may, however, be worthy of more consideration.

The position of the *Sun* among the stars may, however, be determined through the aid of the moon with a considerable approach to precision. The direct comparison of the *Sun* and stars through the sidereal clock is uncertain, from the causes already pointed out, namely, the effect of the *Sun's* rays in disturbing the air and instruments, and personality in observing a limb. Now, by observations of eclipses, especially at the beginning and ending of totality, the exact moment when the *Sun* and *Moon* are in con-

junction is determined with great precision. By observations of occultations the mean position of the moon among the stars is determined with yet greater precision. Hence, by a combination of the two we have a result for the position of the *Sun* among the stars which may possibly be entitled to considerable weight. It is, however, a drawback to the method that few observations of eclipses having any claim to precision were made between 1720 and 1800, while those made before 1720 are of course subject to more or less suspicion of systematic error.

It is worthy of note that this method of determining the position of the *Sun* among the stars is, in principle, that adopted by HIPPARCHUS and PTOLEMY.

The above are the leading features in which the plan of the proposed work differs from that hitherto followed. The objects are also somewhat different, in that they include a basis for future conclusions as well as the determination of astronomical constants and the construction of new tables. It is hoped, should the work be completed on the proposed plan, that for a miscellaneous and frequently inconsistent combination of astronomical constants there will be substituted a consistent set, and that the result of this substitution will be to make it easy to determine, from any future deviation between theory and observation which may show itself, in what direction we are to look for the cause.

RECENT EXPERIMENTS IN THE CONSTRUCTION OF TELESCOPE OBJECTIVES.

C. S. HASTINGS.

(Continued from page 246, Vol. I.)

Anxious to test still farther the theory, I constructed an objective of 6⅓ inches aperture of entirely different materials and curves resembling those chosen by FRAUNHOFER in most of his objectives. This also was made strictly in accordance with the theory and with the most gratifying

results. Of interest to the optician is the fact that its focal length differed by less than $\frac{1}{10}$ of an inch from that given by calculation. The lens is now in the possession of Mr. C. H. ROCKWELL, at Tarrytown, N. Y., and was used by him at Honolulu in observing the last transit of *Mercury*. Though I have not had the opportunity for testing the telescope in astronomical work which I could wish, the ease with which I saw ζ *Bootis* double in 1879 (Hall $0''.55$, 1878.4) and γ^2 *Andromadae* elongated during the same summer, convinces one that it is of the highest excellence, even independently of the severe physical tests to which it had been subjected in my hands.

At the instigation of Mr. ROCKWELL and by means of his generous assistance, the theory was still farther tested in the construction of a larger objective of $9\frac{4}{10}$ inches clear aperture. As there are a number of novel features in this glass and several astronomers and opticians have kindly expressed an interest in the matter, it may be worth while to explain somewhat in detail its peculiarities and process of construction.

In order to secure greater latitude in choice of curves, two very thick disks were ordered from FEIL, and from these, pieces were cut and made into prisms. A careful study of their optical properties, made by means of the Meyerstein circle, yielded data for an elaborate investigation of the most advantageous forms for these particular varieties of glass. It is evident that the problem in this general form is an intricate one for it presents us with seven arbitrary constants, namely four radii of curvature, two thicknesses, and the distance between the two lenses. For the determination of these there are only three essential conditions to be met: a determinate focal length, proper correction for color, and freedom from aberration in light of that wave length which is to effect most strongly the sense of vision. In the ordinary treatment of the problem the last three arbitrary constants named are considered invariable, hence in such cases there remains but one condition to be imposed for the sake of making the solution determinate. In practice the condition is generally that two of the surfaces

shall have the same radius of curvature, as this spares the labor on one pair of tools. In this objective, however, no such limitation was introduced, but all the latitude of choice which the seven arbitrary constants admitted was employed to determine such a form that not only would the three conditions defined be satisfied, but in addition that the spherical aberration for all other wave lengths should be a minimum, and that there should be no "ghosts," *i. e.* images formed by successive reflections, near the focal plane. Of course the practical consideration was not lost sight of, that the construction should be mechanically convenient: to this end the shortest radius of curvature was arbitrarily limited to one-tenth the focal length.

The general nature of the problem rendered the solution extremely laborious, so that it was only after a year from the time of receiving the glass that the work indicated was completed. The values of the optical constants of the glass and the values finally chosen for the seven arbitrary constants are contained in the following table.

TABLE 1.

Crown glass, Feil No. 1404. Sp. gr. 2.563
Flint glass, Feil No. 1406. Sp. gr. 3.516.

Wave Length.	Index ref. Crown.	Index ref. Flint.
A	1.517191	1.605280
C	1.520140	1.610345
D_2	1.522814	1.615122
W. L. 5614	1.524179	1.617613
E	1.526212	1.621366
F	1.529173	1.627020
G	1.534704	1.637931
W. L. 3951	1.539698	1.648177

Flint in advance.
Radius 1st surface, + 121.2 in.
" 2nd. " − 34.22 "
" 3rd. " + 34.48 "
" 4th. " + 108.4 "
Thickness of Flint lens, 0.862 in.
" Crown " 0.808 "
Distance between lenses from 0.1 in. upwards.

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In regard to the distance between the two lenses, as the objective could readily be so mounted that this element could be varied at will through a limited extent, it was thought best to employ this feature as a means of correcting for temperature. Thus the objective is equally good, according to theory, for all temperatures between 0° and 90° Fahrenheit.

It now remained to put the solution to the practical test. Four pairs of iron tools were shaped and ground together so as to have the radii given in the table as determined by my sensitive spherometer. It is true that the most refined accuracy was unattainable at this stage, because the iron tools did not possess sufficient smoothness, but it was easy to get an approximation so close that it required but a few minutes to alter them when the smoothed glass afforded a more delicate test. While a mechanic was employed in this work a glass grinder was, with tools driven by steam, working the disks down to an approximate agreement with the required thickness and curvatures; then the remainder of the operation fell to my own hands. The statements as to what was done by myself shall be very specific, not merely because the following statements have impressed some skilled opticians as very surprising, but because the chief aim of this writing is to illustrate the value of the complete theoretical solution.

The order of proceeding was to grind on one surface until a most careful investigation with the spherometer after it had been "smooth" failed to detect any departure from the reading computed for its particular radius; then another surface was treated in the same way, and, so on; when all the surfaces were thus prepared for polishing, the pitch tools were constructed and the polishing *finished* for each surface in succession; then the two lenses were, one after the other, centered on a lathe and turned to like size. The method chosen for centering, as by far the most delicate, was that of a microscopic examination of reflected images while the lathe was running, the adjustments being made by means of a universal chuck, a special construction of my own. The total time occupied in these processes, starting

with the glasses rough from sand grinding, was fifty hours, distributed over six days. Only after the completion of the centering was the image by the lens examined. There was no expectation of attaining absolute perfection in this way, as no allowance had been made for unavoidable alterations of the curves in polishing, but a very close approximation was confidently expected; and, indeed, so good was the objective that it required only twenty minutes to render it sensibly perfect.

The tests applied so far have been only such as can be derived from observing artificial stars, that is, distant points of light produced either by reflecting surfaces of great curvature in sunshine, or by transmitting light through small holes in an opaque screen; but, as is well known, these are of great delicacy. The tests were as follows:

I. It was found that the probable error of focusing with an ocular, giving a power of a little more than 300, was less than $\frac{1}{2\,0\,0}$ of an inch.

II. When the light was modified by absorption through a piece of yellow glass so as to reduce the effect of secondary dispersion, a high power ocular moving inwards or outwards showed the central disk expanding and exhibiting successively a dark and then a bright disk at the center. This periodic change could be traced on either side of the focal plane until lost by the faintness of the image: it proves to a marvellous degree of precision that the spherical aberration was perfectly corrected. In very many examinations it has never been my fortune to see this degree of excellence in any other large objective.

III. As I had intended visiting Cincinnati at the time of the meeting of the American Association last year, and to give the substance of my experiments there, the lens was sent to the Exhibition of the Ohio Mechanics Institute. As it was regularly entered, it was tested by Prof. Stone, then Director of the Cincinnati Observatory, and Profs. Warder and Wilson, and, at their recommendation, accorded the highest award offered by the society.

Of course the most satisfactory test of the performance of an astronomical objective consists in using it for astro-

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nomical work: but this test has been wanting hitherto because I have not been able to provide the lens with the necessary tube and stand.

Since the telescope objectives named are far better known as regards their optical constants than any others in existence the more interesting of them are appended for the $9\frac{4}{10}$ inch. The list shows at once the character of the color correction and of the correction for spherical aberration, though it is to be observed that these numbers are the result of computation, not of measurement; the relation of the color correction, however, to that which characterizes some of the best large telescopes by prominent makers is fully discussed in the paper, cited above, where the theory of this correction is developed.

TABLE II.

Values of the distances from the vertex of first surface to focal planes, for an interval of 0.25 in. between the lenses, at a temperature of 20° C

Wave Length.	Central Rays.	Marginal Rays.	Spherical Aberration.	Marginal Chromatic Aberration.
A	142.1002 in.	142.0838 in.	+0.0165 in.	+0.1892 in.
C	141.9622 "	141.9501 "	.0110 "	.0555 "
D_2	141.9005 "	141.8954 "	.0050 "	.0008 "
W. L. 5614	141.8948 "	141.8926 "	+ .0002 "	.0000 "
E	141.9027 "	141.9073 "	− .0046 "	.0127 "
W. L. 5000*	141.9438 "	141.9582 "	.0144 "	.0636 "
F	141.9892 "	142.0058 "	.0166 "	.1112 "
G	142.2948 "	142.3335 "	.0387 "	.4398 "
W. L. 3951	142.7386 "	142.7968 "	− .0583 "	.9022 "
For ray of W. L. 5614 at $\frac{2}{3}$ distance from center to margin,		141.8948 in.		

This account will demonstrate that the problem has been finally solved. It is clear that the value of the solution increases with the dimensions of the objective to which it is applied, and for that reason it was tested on as large a scale as possible at the time, but this limit was set by no want of confidence or lack of desire to attempt the largest size for which the glass makers are prepared to furnish material.

*For this value the index of refraction for the Flint only was measured, that for the Crown being computed from this

LOGARITHMIC COMPUTATIONS.

PROFESSOR H. A. HOWE.*

It is assumed that the reader is familiar with the ordinary principles of logarithms as developed in college textbooks: special attention is called to the subjects of negative characteristics, involution, evolution and the signs of the trigonometric functions in different quadrants. He is also supposed to be able to use common logarithmic tables and to get interpolated values of functions from them.

We purpose to explain the construction and use of tables containing addition and subtraction logarithms, (frequently called Gaussian logarithms or Zech), and also to describe certain habits of work by which practical computers facilitate their labor and guard against errors.

I. ADDITION AND SUBTRACTION LOGARITHMS.

If we have a given variable, $\log x$, we can make a table whose argument is $\log x$, while the corresponding function is $\log (1 + \frac{1}{x})$. Zech's addition table, (named after its computer) is such a table. In a seven-place Zech table the argument extends from 0.0000 to 6.0900, and the function from 0.3010300 to 0.0000001.

Suppose that $\log a$ and $\log b$, which is smaller than $\log a$, are given and we wish to find $\log (a + b)$. Subtracting $\log b$ from $\log a$ we got $\log \frac{a}{b}$. With this as an argument, entering the addition table we get the function $\log (1 + \frac{b}{a})$ which equals $\log (\frac{a+b}{a})$. If this function be now added to $\log a$ we evidently get $\log (a + b)$. Hence we derive the following rule:

Subtract the smaller logarithm from the larger: with the remainder as an argument take the corresponding function

*University of Denver, Colorado.

from the addition table; add this function to the larger logarithm.

$\log a$	0.4263435
Zech	0.0307889
$\log b$	9.2924389
$\log \frac{a}{b}$	1.1339046
$\log (a + b)$	0.4571324

In the subtraction table opposite the argument $\log x$ is found the function $\log (\frac{1}{1-\frac{1}{x}})$. Hence if the argument is $\log \frac{a}{b}$ the function will be $\log(\frac{a}{a-b})$, which subtracted from log a will give $\log (a - b)$.

The process then is the same as in addition, except that the function is *subtracted* from the larger logarithm. In Zech's subtraction table when $\log \frac{a}{b}$ exceeds 0.30299, it is to be sought among the functions and the corresponding argument is to be subtracted from $\log a$. Some special cases deserve notice.

1st case. If b (the smaller) be negative and a be positive, $\log (a + b)$ is found by the subtraction table, and $\log (a - b)$ by the addition table; $a + b$ and $a - b$ are both positive.

2nd case. If a be negative and b positive, $\log (a + b)$ is found by the subtraction table, and $\log (a - b)$ by the addition table; $a + b$ and $a - b$ are both negative.

3rd case, If a and b are both negative, $\log (a + b)$ is found by the addition table and $\log (a - b)$ by the subtraction table; $a + b$ and $a - b$ are both negative.

4th case. If $\log (b - a)$ is required, it may be easily obtained from $\log (a - b)$.

II. HINTS ON SEVEN-PLACE LOGARITHMS.

Let it be required to find the mantissa of the logarithm of 2.749648. First fix the number in the mind, by repeating it thus, "twenty-seven, forty-nine" (pause) "six, forty-

eight." To be a successful and rapid computer one must be able to grasp seven figures at a glance. Find in the table the mantissa of 27496. Place the index finger of the left hand directly under the mantissa which is .4392695, and mentally find the difference between this and the next mantissa (.4392853). This difference is 158: by the aid of the table of proportional parts multiply 158 by 0.48 and add the product to the proper mantissa; obtaining in this case .4392771 which may now be written down on the computing sheet. The different operations above mentioned are to be performed mentally, nothing being written down except the final value of the mantissa; if the computer is not quick at figures the subsidiary calculations may be made on a spare sheet of paper, but never on the computing sheet. To test the accuracy of the interpolation, the tabular difference, 158, may be multiplied by 0.52 (which is 1 — 0.48) and the product subtracted from the mantissa of 27497. In getting the logarithms of trigonometric functions the same general principles should be observed.

In using proportional parts the mind should be trained to picture for itself the partial products, one under another and then to add them.

III. ACCURACY OF INTERPOLATED FUNCTIONS.

If a seven-place logarithm be given the corresponding number is usually carried to seven significant figures; with six-place logarithms, it is carried to six figures, etc.

If an angle be obtained from the logarithm of its tangent, with seven-place logarithms, hundredths of a second are used, with six places, tenths of a second etc.: in four place computations tenths of a minute are employed, or only minutes if no great accuracy is desired.

From different logarithm tables we get the following results for A:

log tan A			
9.6438543	23°	46′	8.″51
9-643854	23	46	8.4
9.64385	23	46	7
9.6439	23	46.3	

It is evedent that four-place logarithms do not give tenths of a minute accurately.

IV. NEGATIVE NUMBERS.

If the logarithm of a negative number is required we get the logarithm of the corresponding positive number and write the letter *n* directly after it. Thus, if the number be — 2.6435, its logarithm would be written 0.42218*n*. The letter *n* does not indicate that the logarithm is negative but that the corresponding number is negative.

Skilled computers usually add 10 to all negative characteristics; it is easy from the conditions of the problem to determine whether a characteristic of 7, for instance, represents — 3 or not. In adding two logarithms whose characteristics have thus been increased, 10 is subtracted from the sum. Thus 7.234 added to 9.685 equals 6.919, 7 standing for — 3, 9 for — 1, and 6 for — 4. In subtracting 9.685 from 7.234, 10 is added to the minuend and the remainder is 7.549. Also 9.685 minus 7.234 equals 2.451. Before dividing such a logarithm by 2 (in finding the square root of a decimal number) 10 is added to it. Thus 9.685 divided by 2 equals 9.842. Before dividing by 3, 20 is added.

Number.	Logarithm.
0.064758	8.81130
$\sqrt{0.064758}$	9 40565
$\sqrt[3]{0.064758}$	9.60377
$(0.064758)^2$	7.62260
$(0.064758)^3$	6.43390

V. HINTS ON ADDITION, ETC.

In adding or subtracting two logarithms the process should be performed from left to right, the numbers being divided mentally into groups containing two or three figures each.

$$\begin{array}{r} 0.467489 \\ 0.248356 \\ \hline 0.715845 \end{array}$$

Thus 46 and 24 give 70, but a glance at the succeeding figures 7 and 8 shows that a unit is to be carried: hence we

write 71. 74 and 83 give 157, but again a unit is to be carried and 58 is written. The addition of 89 and 56 gives the figures 45.

An expert computer can add the two logarithms given above more rapidly than he can write the result. Since he can write more quickly from left to right than from right to left, he saves time by adding from left to right. The same order should be followed when multiplying by a small number, such as 2, 3 or 5.

VI. MISCELLANEOUS REMARKS.

Ruled computing sheets are necessary for good work. On a sheet 9 inches by 11 let a rectangle 8 by 10 be ruled and divided by other rules into 80 square inches. Let each square inch be divided by light rules into 25 equal squares. Two figures can be written in each of the smallest squares. It is well to write out a carefully arranged schedule of the work, before making the computation. Time spent in devising a convenient arrangement is by no means lost, especially when a number of computations are to be made with the same formulas.

When a constant logarithm is to be added to a number of others, it may be written near the edge of a small piece of paper and held successively over each of the others.

The computer should sit in such a position relatively to the light, that the shadow of his hand will not fall upon that part of the paper pressed by the pen.

Mental computations are frequently more accurate than those made on paper, because the attention is not distracted by the necessity of glancing from one written figure to another.

A computer ought to be very certain of the accuracy of each step of the work before proceeding to the next; otherwise his mind is troubled with doubts, and rapid, enjoyable work is impossible. It must be remembered that there can be no marked success at computing, without a severe concentration of attention and a steady purpose to work unflinchingly.

VII. LOGARITHM-BOOKS.

The following are standard works. If bought unbound,

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they should be so bound that when opened they will lie open and present a flat page to the eye.

Seven place: Schron, Vega, Bruhns.

Six-place: Bremiker.

Five-place: Gauss, Gernerth (the functions of angles are given at intervals of 10″), Houel, Bremiker (the trigonometric functions are given for each hundredth of a degree)

Four-place: Bremiker (the trigonometric functions are given for each tenth of a degree), Muller, Encke, (small).

Addition and subtraction logarithms are bound up with many books: perhaps the best ones are those computed by Zech, which are carried to seven places.

If only a single book is desired, which shall be useful for all except the most refined computations, and which shall be a model in convenience of arrangement, and ease of use, Bermiker's six-place table is to be recommended. With it are bound Gaussian logarithms. An edition whose preface and introduction are in English, bears the imprint of Charles and Edwin Layton, 150, Fleet street London.

ASTRONOMICAL PHOTOGRAPHY.

PROFESSOR E. C. PICKERING.

The important part that photography is likely to play in the future of astronomy renders it desirable that an opportunity should be afforded to astronomers to acquaint themselves with the improvements continually made in this branch of their science. This could best be done by the establishment at convenient places of collections designed to exhibit the progress of photography as applied to astronomical observations.

The Harvard college observatory has some special advantages for forming such a collection, since it already possesses many of the early and historically important specimens which would naturally form part of the series. Among these may be mentioned four series of daugerreotypes and photographs of various celestial objects taken in

this observatory. These series were respectively undertaken in 1850, 1857, 1869, and 1882.

At present, the astronomers of the United States have no ready means of comparing their own photographic work with that done in Europe, or even with that of their own countrymen. The proposed collection of photographs, so far as it could be rendered complete, would greatly reduce the difficulty.

It is therefore desired to form, at the Harvard college observatory, a collection of all photographs of the heavenly bodies and of their spectra which can be obtained for the purpose; and it is hoped that both European and American astronomers will contribute specimens to this collection. Original negatives would be particularly valuable. It may happen that some such negatives, having slight imperfections which would limit their value for purposes of engraving, could be spared for a collection, and would be as important (considered as astronomical observations) as others photographically more perfect. In some cases, astronomers may be willing to deposit negatives taken for a special purpose, and no longer required for study, in a collection where they would retain a permanent value as parts of a historical series. Where photography is regularly enployed in a continuous series of observations, it is obvious that specimen negatives only can be spared for a collection. But in such cases it is hpoed that some duplicates may be available, and that occasional negatives may hereafter be taken for the purpose of being added to the collection, to exhibit recent improvements or striking phenomena.

When negatives cannot be furnished, glass positives, taken if possible by direct printing, would be very useful. If these also are not procurable, photographic prints or engravings would be desirable.

In connection with photographs themselves, copies of memoirs or communications relating to the specimens sent, or to the general subject of astronomical photography, would form an interesting supplement to the collection. A part of the contemplated scheme will involve the preparation of a complete bibliography of the subject, including a

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list of unpublished photographs not hitherto mentioned in works to which reference may be made.

ARABIC NAMES OF THE STARS.*

Although modern astronomers are disposed to set their faces against the retention of the old names for the individual stars which figure so abundently in the earlier atlases and on our celestial globes, yet they are not without their interest and value. But few of them can be expected to have any considerable lease of life in our catalogues and text-books, perhaps none besides those to which the 'Nautical Almanac' has offered an asylum, for a letter or a number affixed to a star serves all the purposes of modern astronomy as well and better. Still, obsolete for practical purposes, they will ever retain a certain archæological value; and an enquiry therefore into their etymology with a view to establishing their true orthography and meaning is not altogether devoid of interest, nor unworthy attention even in such practical days as our own.

The work before us is a neat little volume, written with just this purpose, to exhibit the meaning and correct the spelling of the old star-names. It is intended as the forerunner of a larger book which the author hopes to publish later on, upon the names connected with the Stars and Constellations; but fearing lest he should find himself forestalled, and should so lose all credit for the arduous labors and research of many months, the author has hastily compiled the present work so as to establish his priority. The signs of haste are, however, limited to a few obvious mistakes, and the little book as a whole is well put together and clearly arranged.

The flavour of romance which seems to cling around names like *Betelgeux* and *Alderamin*, *Azelfafage* and *Dene-*

*The names of the Stars and Constellations compiled from the Latin, Greek, and Arabic; with their derivations and meanings; together with the twenty-eight Moon-stations of the zodiac, known to the Arabs. By W H. Higgins, M. B. (Copyright.) Leicester: Samuel Clark, 5, Gallowtree Gate. London: Hamilton, Adams, and Co. 1882. 57 pp. Editor, E. W. Maunder, in *Observatory*.

bola somewhat evaporates when the words are explained. For the most part we find that the stars are named simply from their positions in the various constellations; thus *Betelgeux* is the Giant's, *i. e.* Orion's shoulder; *Alderamin* the right arm, *i. e.* of Cepheus. *Denebola* the Lion's tail. Prosaic as this explanation is, it gives the names a value they would not otherwise have, for we are enabled thus to trace out to some extent the limits of the original constellations and to perceive in what attitudes the figures attached to them were supposed to stand. Thus the name *Phact* of α Columbæ tells us that it was once the thigh of Canis Major; *Alpheratz*, the name of α Adromedæ, shows that it has been stolen from the horse, Pegaus; who has lost another star in π Cygni, *Azelfafage* the Horse's hoof.

Two stars, *Vega* and *Altair* (for *an nas'r al Waki* and *an nas'r at Tayr*), the falling and flying Eagles, are interesting as showing that they were bestowed in a much more southern latitude than ours, where Vega passed the meridian north of the zenith and hence seemed to be directing its flight from it instead of south of it as with us, with whom the constellation seems to be soaring upwards.

Some of the names, however, still remain unintelligible; probably their spelling has become so corrupted in the course of ages, that their true origin remains inexplicable. Thus it would seem strange if the Barker's Corner were the true rendering of *Zavigava*, β Virginis; nor is it clear why ε Canis Majoris should be called the Virgins, if that was the original meaning of *Adara*. Here and in one or two other instances Mr. Higgins distinctly improves upon Smyth and Ideler, for he suggests the etymology *ad dhahr*, the back, of Canis Major that is, instead of *al adhara*, the Virgins.

The mention of Admiral Smyth's name reminds us that Mr Higgins would seem not to be acquainted with the 'Celestial Cycle,' as he says, p. 4, that "no English writer on Astronomy seems to have had any interest in tracing these 'Star Names' to their original language and thus assigning some meaning to them."

There is another English writer on Astronomy besides Admiral Smyth who has made a study of the star-names, but

who unfortunately worked with far more zeal than discrimination. It is many years since "Mazzaroth" first appeared: but the strange and fanciful etymologies there put forth have led many a reader astray, and at least one book published in the past year was founded entirely on Miss Rolleston's explanations, which have even found their way into official catalogues. Yet a very little consideration, even where all knowledge of Arabic or Hebrew was wanting, would surfice to suggest that Arabic names were more likely to find an explanation in the Arabic language than in supposititious Hebrew roots, and that meanings like that of Right arm for *Alderamin*, the star in the right arm of Cepheus, or of Breast for *Schedar*, the star on the breast of Cassiopeia, were far more probable than Miss Rolleston's interpretations of 'Coming quickly as in a circle," and "Freed," which have no obvious reference to the figures with which they are connected.

There are two cases, however, where Miss Rolleston has most manifestly tripped, and, oddly enough, Mr. Higgins slso has made a slight slip in both instances The two principal stars of Libra are generally known as *Zubenelgenubi*, for α, and *Zubeneschemali* for β. These Miss Rolleston intnterprets as the "Price Deficient" and the "Price which Covers." Unfortunately, however, the scale marked with the stigma of deficiency, and which should therefore "kick the beam," is the one in which α shines, and is therefore really the southern and preponderating scale. The true explanation is that the names recall the time when the Scorpion held a double portion of the zodiac, and *Zubeneschemali* for β, the northern star, simply means the "Northern Claw," and *Zubenelgenubi* the "Southern Claw," Mr. HIGGINS, probably by a printer's error, gives Alpha's title to Beta and *vice versa*.

The other instance is found in the names of α and β Delphini, *Svalocin* and *Rotanev*. Mr. HIGGINS' comment is, "The above words spelt backwards give the name Nicholas-Venator. From Niccolo Cacciatore=an Italian, who was a huuter." This is nearly, but not quite, the full solution of the riddle. The true history of their origin, first given, we

believe, by Dr. Gould, is thus rendered by Flammarion in 'Les Etoiles':—

"The search for the original Arabic of these names long baffled the utmost ingenuity of Admiral Smyth, as we can easily understand when we learn that they are only due to a somewhat childish joke of an astronomer in a joval mood,—no doubt of Piazzi himself. These two names when reversed make, in effect, *Nicolaus Venator*; and the companion of Piazzi, at the Observatory of Palermo*, was none other than Niccolo Cacciatore, who died in 1841. Every one knows that *cacciatore* signifies hunter, in Latin *venator*. These two stars then simply bear the names of Nicolas Cacciatore, latinised and reversed!"

Miss Rolleston was not daunted by the uncouth aspect of these "cacophonous" words; and with a little alteration, no greater than many another star-name had to suffer at her hands, they slipped neatly into their proper places in her system, thus:—"Arab *Scalooin*, swift (as the flow of water);" and Syr. and Chald., *Rotaneb* or *Rotanev*, swiftly running (as water in a trough)."

THE SOLAR ECLIPSE OF 1883, MAY 6.—Although the only stations from whence the eclipse can be satisfactorily observed are so distant, it has been felt that the results obtained during the brief totality of the eclipse of last May are so important that the opportunity afforded by the much longer duration of the forecoming eclipse is not one to be neglected. The English observers, Messrs. C. R. Woods and H. A. Lawrence, who acted as assistants to Dr. Schuster and Mr. Lockyer in Egypt last year, have therefore left England with the intention of joining the American Expedition at Panama, from whence they will proceed to Caroline Island near the Marquesas, where the total phase will last for nearly $5\frac{3}{4}$ minutes.—*Observatory.*

The new Minor Planet, discovered Jan. 31, 1883, is No. 232, with magnitude 12.5.

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*And in the preparation of Piazzi's Catalogue, in which the names first appear.

EDITORIAL NOTES.

The discovery of the first comet for the year was announced, in our last issue, as belonging to Professor SWIFT of Rochester, N. Y. While it is true that Professor SWIFT independently discovered the comet, Feb. 23, at a few minutes past seven o'clock in the evening, it later appears that Professor WILLIAM R. BROOKS, of Phelps, N. Y., first saw it at six o'clock and forty-five minutes on the same evening, thereby anticipating Professor SWIFT in the discovery by about fifteen minutes. Professor SWIFT promptly reported that the first honor belonged to Professor BROOKS, as soon as the difference in time was ascertained. The telegrams announcing these independent discoveries reached Harvard college observatory only seven minutes apart, while telegrams from Harvard college observatory and Professor SWIFT were received at Carleton college observatory by the same messenger. On the same day, Professor BROOKS sent us the following note which came too late for the March MESSENGER.

"It was my good fortune this evening, Feb. 23rd, at 6 hours 45 minutes, to discover a new, bright telescopic comet in the constellation *Pegasus*, approximately R. A. 22 hours 50 minutes, north declination 28 degrees. Motion eastward. It has a large, bright head, very condensed, and a delicate, narrow tail.

Telegraphic announcement has already been made by me this evening, with instructions to cable the discovery to Europe. I discovered the comet with the 9-inch reflector, but it may be well observed with small telescopes."

As given by *Science Observer* circular, the following positions were obtained at Harvard college observatory, or were communicated to it:

Feb. 1883.					A. R.			Decl.			
d.	*h.*	*m.*	*s.*		*h.*	*m.*	*s.*	°	′	″	
24	7	13	49	Camb. M.T.	23	7	23.23	+30	27	44.0	East Equatorial.
26	7	18	1	" "	23	26	14.76	31	10	26.2	East Equatorial.
26	7	34	45	" "	23	26	19.93	31	10	10.2	West Equatorial.
27	7	18	13	" "	23	35	46.68	31	27	3.9	East Equatorial.
27	7	26	29	" "	23	35	50.61	31	27	22.4	West Equatorial.
27	7	39	12	" "	23	35	54.18	31	27	22.4	East Equatorial.
25	8	2		Nash. M. T.	23	17	33	30	52	41	
26	8	17		" "	23	27	5.	31	11	57	Prof. Landreth.
26.5666				Green. M. T.	23	26	51.0	31	11	39.	Prof Pritchett.
27	8	12		Nash. M. T.	23	36	34	31	28	25	
Mar.	1883.										
4	7	8		Camb. M. T.	0	23	51.19	+32	1	37.9	

In consequence of cloudy weather on the 25th inst., telegrams were sent to western observatories requesting positions; and, in reply to these, two positions were received from Prof O. H. LANDRETH, of Nashville, Tenn., and one from Prof. C. W. PRITCHETT, of Glasgow,

Mo. The Nashville position given above, arrived after the orbit was computed, and the other could not be used. From Cambridge positions, and third from the last, in the above table, which was received in a Code message from Prof PRITCHETT, the following elements and ephemeris have been computed by Messrs. Chandler and Wendell:—

ELEMENTS.

Time of Perihelion Passage = February 17.345. Greenwich, M. T.

Longitude Perihelion	= 23	39.7	Mean Eq. 1883.0
Longitude Node	= 275	55.1	
Inclination of Orbit	= 78	54.9	
Perihelion Distance	= .75954		

EPHEMERIS.

Greenwich midnight.		A. R.			Decl.		
		h.	m.	s.	°	′	″
March	5.	0	32	51	+32	0	
	6.	0	42	6	31	55	
	7.	0	51	11	31	47	
	8.	1	0	8	31	37	
	9.	1	8	54	31	24	
	10.	1	17	28	31	9	
	11.	1	25	50	30	52	
	12.	1	34	0	30	33	
	13.	1	41	56	30	12	
	14.	1	49	39	29	50	
	15.	1	57	9	29	27	
	16.	2	4	25	29	2	
	17.	2	11	28	28	36	
	20.	2	34	38.8	26	52	29
	24.	2	58	48.6	24	50	54
	28.	3	19	58.6	22	48	34
April	1.	3	38	35.6	20	49	40
	5.	3	55	5.5	18	56	22
	9.	4	9	50.8	17	9	39
	13.	4	23	9.7	+15	29	43

The correction to this ephemeris, as indicated by observation on March 4, is A. R. + 23s. and Declination − 0′.8.

From the late annual report of Professor PICKERING, as director of Harvard college observatory, knowledge of recent important astronomical work is gained. Objects having singular spectra have been searched for systematically; several minute planetary nebulae have been found near the *Milky Way*, but none at a distance from it, and a special search for these objects last summer in the *Milky Way* from −30° to +20° resulted in the discovery of seven new ones previously reported in the

MESSENGER. Most of these objects are so minute that they can not be distinguished from stars by the ordinary eye-piece. Photometric work on the satellites of *Mars* confirms that of 1877 and 1879, except that the brightness of *Deimos*, when preceding and when following *Mars*, does not seem to change as formerly noticed. The determination of the brightness of various points on the *Moon* to aid the work of the Selenographical society is now completed. From this investigation, it appears that the scale of brightness, in use by common observers of the *Moon* is closely expressed in terms of stellar magnitudes, each degree in the scale answering to the ratio of light equivalent to six-tenths of a magnitude. The wedge photometer is principally used to measure the light of faint stars in zones. It is so placed in the instrument that the diurnal motion of the stars carries them from its thin to its thick portion, and the time of their disappearance is noted to determine their brightness. The careful study of SAWYER'S variable star, D. M. + 1°, No. 3408, proves it to be a very interesting object. Its period of variability is 20h. 7m. 4s. 1.6, being the shortest known belonging to the Algol class. Its variation is from 6.0 to 6.8.

The telegraphic system devised by those in charge of the *Science Observer* for the speedy transmission of comet news has been improved, extended and will probably soon come into general use. Progress has been made in the reductions of the meridian circle work from 1870 to 1879. These observations will make about 1,200 printed pages and will fill three volumes of the Annals. Vol I will contain an introduction with discussion of instrumental constants, etc; II will contain all the zone observations in journal form, and III, observations of secondary polar stars made in 1872-73, a list of stars for U. S. coast survey in 1878, and other similar work in 1879. This important work is already well advanced under the direction of Professor W. A. ROGERS. The Coast Survey catalogue is now ready for publication.

The work of the meridian photometer has been considerable. Over 90,000 measures were made last summer on about 4,000 stars visible to the unaided eye. This work involves the discussion of several problems of general interest in connection with the light of the stars, among which may be mentioned atmospheric absorption. The discussion of about 15,000 observations shows this curious result: that we may assume the absorption at any altitude exceeding 15° to be equal in stellar magnitude to one quarter of the secant of the zenith distance which agrees very closely with the impirical law deduced by SEIDEL.

Though some have claimed that the Pole star is variable, its constancy is established by the photometer.

Other valuable matter in this report pertains to variable star work, equatorial observations, scientific papers published, and concerning plans for the future.

Frequent reference has already been made from time to time, in these pages, to Professor S. P. LANGLEY's studies in solar physics as kindly communicated by himself, or gained from other trustworthy sources. His investigations in this difficult theme have attracted the attention of astronomers alike in Europe and America from the beginning, and very gratifying notices of his work as it has progressed have already appeared in all the leading scientific journals in the world.

In a course of lectures recently given before the Lowell Institute, Boston, and in late papers published which were carefully prepared and illustrated, the character and scientific value of his researches more fully appear. The latest paper that we have seen is entitled "*The selective absorption of solar energy.*" Its introduction refers to the work of 1880, when attention was given to devising and perfecting a new instrument called a bolometer, which is more sensitive than the thermopile. The last named instrument indicates the *presence* of feeble radiation, the bolometer accurately measures it; and so it has been determined that every ray whether lying in the chemical, visible, or heat region of the spectrum "is capable of making itself known as heat and that the maximun of heat in the normal spectrum is near the yellow." The preliminary observations made at Allegheny in 1880 show something of the intricacy of the problem, and the patience and skill early applied to its solution. In July, 1881, an expedition to Mt. Whitney in southern California was fitted out and instrumentally equipped at the Allegheney observatory, for the purpose of furthering this important investigation under favoring circumstances. The description of apparatus used, mode of observation and reduction and the advantages of high altitudes in such work are admirably set out in this paper. It concludes with a summary of results briefly stated as follows:

1. The maximun energy is above the red and is placed in fact near the yellow. In this diffraction and prismatic spectra essentially agree.

2. For high and low sun in altitude, different parts of the spectrum are affected very unequally, indicating an enormous systematic absorption, increasing toward the ultra-violet and diminishing toward the infra-red. Roughly speaking absorption in the spectrum follows the law of wave-length inversely, *i. e.* where wave-length is shortest, absorption is the greatest and *vice versa.*

3. That the hottest part of the spectrum outside of the atmosphere will be found rather in the green, than near the yellow when observed in the atmosphere. It is probable that the sun would appear of a decidedly bluish tint to the naked eye placed beyond our atmosphere.

4 Previous observations have made the solar constant between 1.7 and 2.5 calories.

The Mr. Whitney observations certainly increase its value, making it probably near 3 calories.

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5. It is probable that all energy, in any ray, can be exhibited if there be a proper medium to receive this energy.

6. The ratio of luminous to dark rays has been wholly changed by the selective absorption.

It is evident that these researches have a practical bearing of great consequence. It has been hitherto snpposed that the temperature of the earth, the existence of human and all organized life depended on the direct solar heat, almost entirely. It now appears that the quality of *selective* absorption of our atmosphere has an important place and is a potent factor in the life problem.

It is known to astronomers generally that Dr. B .A. GOULD, director of the national observatory at Cordoba, Argentine Republic, completed not long ago, a work entitled 'Uranometria Argantina'. This work was an extension of Argelander's scale of magnitudes to all the stars which can be seen by the naked-eye, without instrumental aid, between ten degrees north declination and the South pole. The observations, notes and references are neatly printed in book form, both in Spanish and English, and are accompanied with a series of charts, exhibiting on a stereographic projection, the positions of all these stars to the sixth magnitude, with a proposed revision of the boundaries of the southern constellations. At a late meeting of the Royal Astronomical Society the Gold Medal of the Society was awarded to Dr. GOULD for his 'Uranometria Argentina.' Another merited honor to American astronomy.

Late valuable papers received from the Royal observatory at Greenwich give observations on the spectrum of the great sun-spot of 1882, Nov. 12–25; and the spectroscopic results for the motions of stars in the line of sight observed in the year 1882. The last named papers show that the motions of 99 stars in the line of sight, in miles per second, have been spectroscopically determined, though the result in many cases are still claimed to be uncertain. These results will soon be printed in tabular form.

Professor W. HARKNESS gave us interesting particulars concerning the construction of a piece of apparatus designed by himself some time ago, for the purpose of measuring photographs of the transit of *Venus*. The divided scale by which linear measures are taken under microscopic power is said to be a piece of Mr. Rutherford's most careful workmanship, and its errors are exceedingly small. The great number of measures to be taken on every picture to determine its value, and the exact position of the planet, indicates something of the mass of work before the Professors in charge of it for the next few years.

M. THOLLON and GOUY observed its spectrum of the great comet Sept. 18, 1882, to determine its motion in the line of sight. Their results showed that the comet was receding at the rate of 47 or 38 miles per second. Since, its orbit has been computed, and its motion in September last determined to be 45 miles per second; a very close result to be obtained with a spectroscope of small dispersive power.

During our late visit in Washington, Professor J. R. EASTMAN kindly showed specimens of the photographic work of nearly all the government parties under the direction of the transit-of-Venus-commission. These pictures show the disc of the sun with a diameter of about 4 inches, and a hasty view of a large number indicated generally clear and sharp work. Some new and curious freaks in the photographic art will doubtless be mentioned in the discussion of some of these pictures.

Professors FRISBY and HALL were also found at their desks busy with the reductions of ordinary work. The old and the new comets were being observed every favorable night, for positions, and to test the ephemeris of the former. It is indeed gratifying to notice that the latest observations of the great comet of 1882 show that it is holding very closely to the ephemeris computed for it by Professor FRISBY.

General W. B. HAZEN, Chief Signal officer, manifests a lively and constant interest in all astronomical work that has immediate public uses, especially when the same is connected with the efficiency of his own department. His proffered co-operation with observatories, for the purpose of maintaining time-ball service in large commercial centers for the public benefit, gives to the service a dignity and support that the public will appreciate.

Professor C. ABBEY, Signal Service, Washington, D. C., lately gave us some excellent ideas respecting the needed apparatus to receive or properly arrest time-balls falling from a height of 20 feet or more. He suggests the construction of an inexpensive air-chamber, into which the ball should fall, the air beneath the ball to act both as a cushion and a break. After trial of this plan the results will be reported.

At Philadelphia we met our genial friend, P. O. KNIPE, who is in charge of the astronomical department in the firm of Messrs. James W. Queen & Company. His thorough knowledge of optics and the construction of astronomical instruments make him a useful man for that place. The variety of excellent scientific instruments which may be secured at this place on short notice is far greater than we had supposed.

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While passing through Baltimore on the 7th ult., we were fortunate to be present at a meeting of one of the university societies, during which Professor ROWAND gave a paper on recent experiments in photographing the solar spectrum. By means of large concave gratings ruled by himself, wonderfully great dispersive power is secured, which seems still to give a spectrum in detail sufficiently bright for the purpose of photography. The direction of study of late has been to devise a plate chemically prepared, having greater sensitiveness than any now in use, so that pictures may be taken of the invisible part of the spectrum. Negatives and proofs of Professor ROWLAND'S work were exhibited, and we were delighted to see a scale of work in the photography of the spectrum that would make it anywhere from 60 to 200 feet long. The object of these researches is, finally, to make a standard map of the solar spectrum.

The prominence which photography is assuming as a means of observation and record in physical astronomy is surprisingly great. While at the Harvard college observatory recently, Professor PICKERING cordially invited us to examine photographs taken by the aid of telescopes of small aperture and large field. Pictures were shown exhibiting plainly stars of the seventh magnitude. Of course it is known that stars of the 13th, and even lower magnitudes, have been photographed by delicate and powerful apparatus, devised by specialists in the art; but good, clear results in mapping the heavens by the aid of two-inch telescopes, with brief exposures, were not anticipated It is also plain from what we saw that photography is to give aid in the study of the colors of the stars.

For a more definite knowledge of the comparative value of different kinds of sensitive plates used in the dry process of photography, we visited the laboratory of Professor W. H. PICKERING, at the Massachusetts Institute of Technology, Boston. Professor PICKERING has given much study to this theme, and by a series of experiments already completed, is prepared to render great service to those who are studying the art. The MESSENGER has the promise of an early paper embodying the substance of his investigations.

By the generosity of a noble friend in Minnesota, Carleton college observatory is to have a new, large meridian-circle of the same general pattern as that recently imported by Profsssor SAFFORD, to which reference has already been made. The REPSOLDS, of Hamburg, Germany will need one and one-half years to make it.

As usual, much valuable matter must be deferred for the want of space.

OBSERVATIONS OF BROOKS' COMET, MADE WITH THE SIX-INCH EQUATORIAL OF THE VANDERBILT UNIVERSITY OBSERVATORY.*

No.	Date. Washington, M. T.	App. A. R.	App. Decl	No. of Obs.
	1883. h. m. s.	h. m. s.	° ′ ″	
1	Feb. 26.3 8 53 46.7	23 27 2.9	+31 12 9	4
2.	" 27.3 8 51 13.7	23 36 34.66	31 28 47	6
3	" 28.3 8 56 42.6	23 46 9.1	31 41 47	3
4.	Mar. 1.3 8 36 51.5	23 55 42.7	31 51 24	2

	W'n M. T.	$\Delta\alpha$(C — S)	App. A. R.	$\Delta\delta$(C — S	App. Decl't'n	
	h. m. s.	m. s.	h. m. s.	′ ″	° ′ ″	
5.	Feb. 25.3 8 45 16.7	+1 21.2	23 16 12.24	−17 47.6	+31 10 22.8	5
6.	" 27.3 8 9 12.2	−0 49.4	[ ]	− 2 46.0	[3]	6
7.	" 28.3 8 40 29.1	−1 11.4	23 46 4.83	− 4 6.6	31 41 26.5	6
8.	Mar. 1.3 8 9 22.7	+2 35.1	23 55 26.94	+ 7 32.0	31 51 27.2	4

MEAN PLACES OF COMPARISON STARS.

No.	Mag.	Mean A. R. (1875.0)	Mean Declination, (1875.0)	Authority
		h. m. s.	° ′ ″	
5.	6.	23 15 48.88	+31 7 40.2	Prof. T. H. Safford's Wash'ton catalogue.
6.	8.	[23 37 4.	31 30 43.]	Approx. App. place, by Equot. pointing.
7.	8.	23 46 51.26	31 42 47.6	Leyden Zones No. 118 and No. 123
8.	6.2	23 52 27.01	31 41 9.6	Leyden Zones No. 112.

Observations No. 1, 2, 3 and 4 were obtained by taking transits over a pair of right ascension and declination cross-wires sufficiently course to be visible without artificial illumination. They are corrected for true refraction, and for error of equatorial circles. Observation No. 5 was made by a ring-micrometer which was not available on the other nights. This, as well as the following observations, is corrected for differential refraction. Observations Nos. 6, 7 and 8 were made by taking transits of comet and comparison star over the same reticule of cross-wires as in Nos. 1, 2, 3 and 4, but with the wires turned 45° (by position circle) from direction of sidereal motion. The eye-piece with reticule was rotated 90° at the middle of each set of observation to eliminate the effect of any outstanding error of perpendicularily between the two wires.

This method of observation gives

$$\Delta\alpha\,(C - S) = \tfrac{1}{2}\,[(t'' + t') - \overset{3}{t} + \overset{2}{t})], \text{ and}$$

$$\pm\,\Delta\,\delta\,(C - S) = \frac{15\cos\delta}{2}\,[(t'' - t') \pm (\overset{3}{t}. - \overset{2}{t}.)]$$

*Made and communicated through the courtesy of Dr. L. C. GARLAND, Professor of Astronomy, Vanderbilt University, Nashville, Tenn.

Where C and S, are comet and star, t′ and t″ are the transit times of the comet over the 1st and 2nd wires, and where t_2 and t_3 are the transit times of the comparison star over 1st and 2nd wires.

The double signs in the expression for $\Delta\delta$ (C — S) are rendered determinate by noting the relative positions of the comet and star as referred to the intersection of the cross-wires, and to the equator.

I am inclined to think this method preferable to that of the ring micrometer, as it is more easily provided, requires no determination of any *constant*, involves no error consequent on imperfection of focal adjustment, maintains a constant inclination between the path of the objects observed and the transit wire and without placing the two objects unsymmetrical permits the use of any portion of the field rendered necessary by the distance apart of the two objects.

I am indebted to Messrs. S. C. Chandler and J. Ritchie, Jr., of Harvard observatory, for the places of comp. stars Nos. 5, 7 and 8. Comparison star No. 6, could not be identified in the catalogues, and the position of the sun has hitherto prevented my determining its precise position. The clock error was well determined. On Feb. 26th, a straight, slender tail could be traced for about 1° 10′.

Its junction with the coma was eccentric by about one-third the radius of the coma being that distance west of a line through the nucleus.

Latitude of obserqatory +36° 8′ 58.25″

Longitude of observatory +0^h 39^m 0.68 from Washington.

OLIN H. LANDRETH, Prof. of Engineering,
Vanderbilt University, Nashville, Tenn.

E. E. BARNARD of Nashville, Tenn., has been elected to a fellowship in astronomy at Vanderbilt university, taking effect March 1. His position will enable him to prosecute his astronomical studies, having full access to the fine instruments at the university and with a salary sufficient to enable him to devote his whole time to his adopted science. He will be stationed at the university grounds. Mr. Barnard, now freed from the embarrassments under which he has been laboring will have his whole time to devote to the science he loves so well. He is young, energetic and talented and a bright future is before him.

Messrs A. CLARK AND SONS have completed the great object-glass of 30 inches clear aperture for the Russian government, and Professor STRUVE and his son are expected to arrive in America about April 1, on business connected with its manufacture and transportation to Europe.

In January MESSENGER, page 271, third word in line 13 from the top, read 'no' for 'an.'

Dr. T. D. SIMONTON, of St. Paul, March 21, communicated to us the following interesting notes and observations:—

"As no eclipse of Jupiter's 4th satellite, has occurred since June, 1880, I have noted with considerable interest, that one was announced by the Ephemeris for the 18th inst. Looking for it about the time I was all the more interested to see that it *did not come off* according to prediction—unless the times, "disappearance $10^h\ 28^m$," and "re-appearance $11^h\ 57^m$," were not to be taken strictly, but as indicating probable limits of observation. If they were to be taken strictly the Ephemeris is in error. I give you the results of a careful observation of the phenomenon with a three-inch achromatic, Washington time.

As I had never noticed a predicted eclipse of the satellites to fail, by a minute even, it was a great surprise to see this 4th satellite, though faint beside two others near at hand, continue plainly visible minute after minute beyond the predicted time. And this continued up to $10^h\ 50^m$, when for the first time I was sure of a diminution of light. There was now a rapid waning, till at $10^h\ 55^m$, if visible at all, the light of the body was excessively faint. This continued but a minute or two, however, when I was sure of it again by glimpses, and in a minute or two more, before $11^h\ 0^m$, could see it steadily. As it now grew in brightness I ceased looking before $11^h\ 10^m$. We have here I suppose a return of the conditions bringing about a stated eclipse of this satellite, though in this first predicted instance I doubt if for a single moment the whole body was brought within the sweep of the great shadow of its primary."

March 14, MR. JOHN R. HOOPER, of Baltimore writes: "I have been observing the new comet, whose only special feature seems to be its comparative great mass of haze and slight thin tail. Comet Gould is still in view, but last night was only just discernable, the sky showing some moon light I think that when the moon is past, the comet will be beyond the power of a five-inch glass."

MR. HOOPER has sent us eight sketches of Comet Gould as it was seen between Jan. 29 and March 13, when the moon was seven days old. He also favors us with a good sketch of the Brooks-Swift comet as seen March 12.

Our frontispiece gives a view of the interior of the dome of Warner observatory, Rochester, N. Y. The great refractor is the third in size in the United States. It was made by the Clarks and has an object-glass of 16 inches clear aperture.

The many friends of Professor W. A. ROGERS of Cambridge, will be sorry to learn of late illness that confined him to his room for some time last month.

XUM

Professor H. A. Howe, University at Denver, favors us, this month, with an article on the use of logarithms in astronomical computations. Its perusal will aid young computers who found trouble in following his previous excellent model for computing the parabolic orbit given in numbers 8 and 9 of the Messenger. Professor Howe's work in pure mathematics and practical astronomy justly entitles him to high rank among working astronomers of maturer years.

Professor T. H. Safford of Williams college observatory kindly invited us, a few days ago, to an examination of his new meridian circle made by the Repsolds of Germany. It is indeed a finished piece of workmanship, and its scientific working power, so far as tested by Professor Safford shows extreme delicacy and high excellence. A full description of this instrument and its fire-proof house will be given subsequently.

Computors will be glad to learn that Professor Safford is soon to contribute an article for the Messenger which will contain new and important checks for the computation of comet orbits. The serious mistakes of last summer in getting the true orbit of the great comet in which experienced computors haplessly found themselves, was partly due, we belive, to the fact that difficult parts of the work were not carefully checked.

H. E. Mathews of the Lick observatory, California, informs us that the 'crown' glass, (a noble disc thirty-six inches in diameter,) for the great equatorial of that observatory was, in February last, placed in the annealing pot by the makers in Paris. The 'flint' disc, its companion is now in the hands of the Clarks, at Cambridge.

The failure or inability of our engraver to complete work ordered, in time, leaves us without desirable illustration of the new comet, the drawings of which were kindly furnished by Messrs. Brooks and Hooper.

Messrs Fauth & Co., instrument makers, Washington, D. C., have just issued a new catalogue, setting forth in a complete and tasteful way, the business of this popular manufacturing firm.

Mr. George Gildersleve, of Baltimore, made early observations of the new comet after its discovery. He was able to see it with the unaided eye under favoring circumstances.

The accidental omissisn of Mr. Numsen's late observations of stars in *Scorpio* is greatly regretted.

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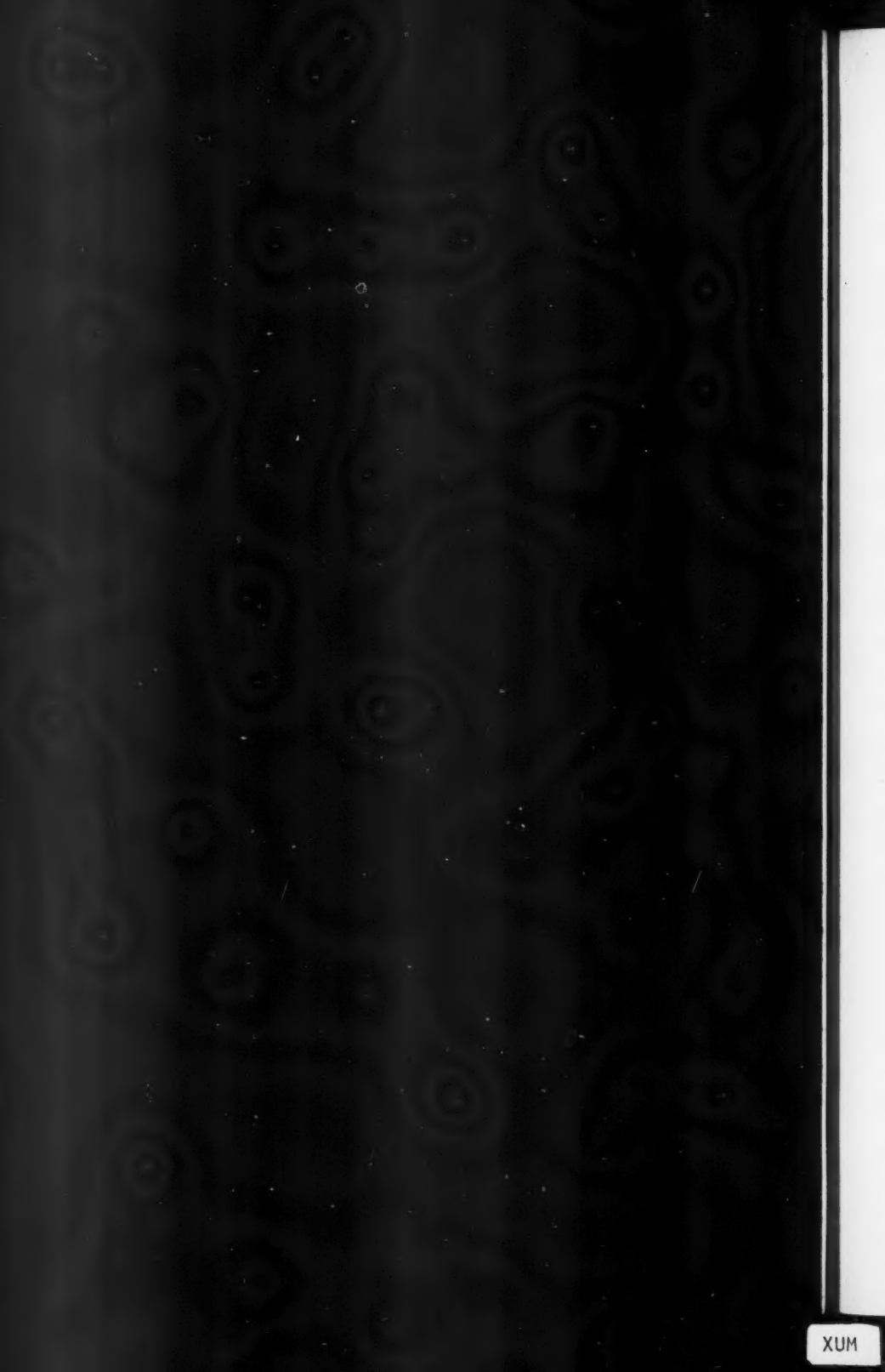
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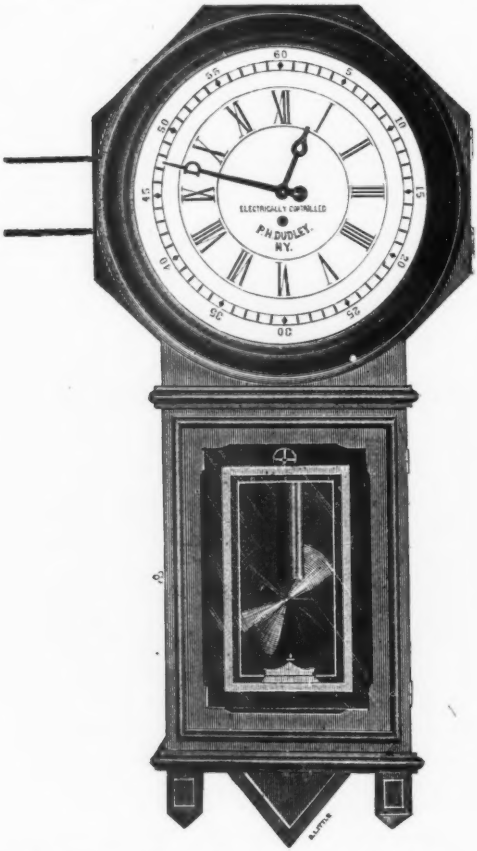

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